



# **Climatological Means and Variations of Tropical Precipitation and Its Relationship With Surface Temperatures from 15 years of TRMM Data**

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# TRMM Sensors

## Microwave radiometer (TMI) [U.S.]

10.7, 19.3, 21.3, 37.0 85.5 GHz (dual polarized except for 21.3 V-only)  
conical scanning ( $53^\circ$  inc.)  
at 5.1 km resolution at 85.5 GHz  
878 km swath

## Precipitation radar (PR) [Japan]

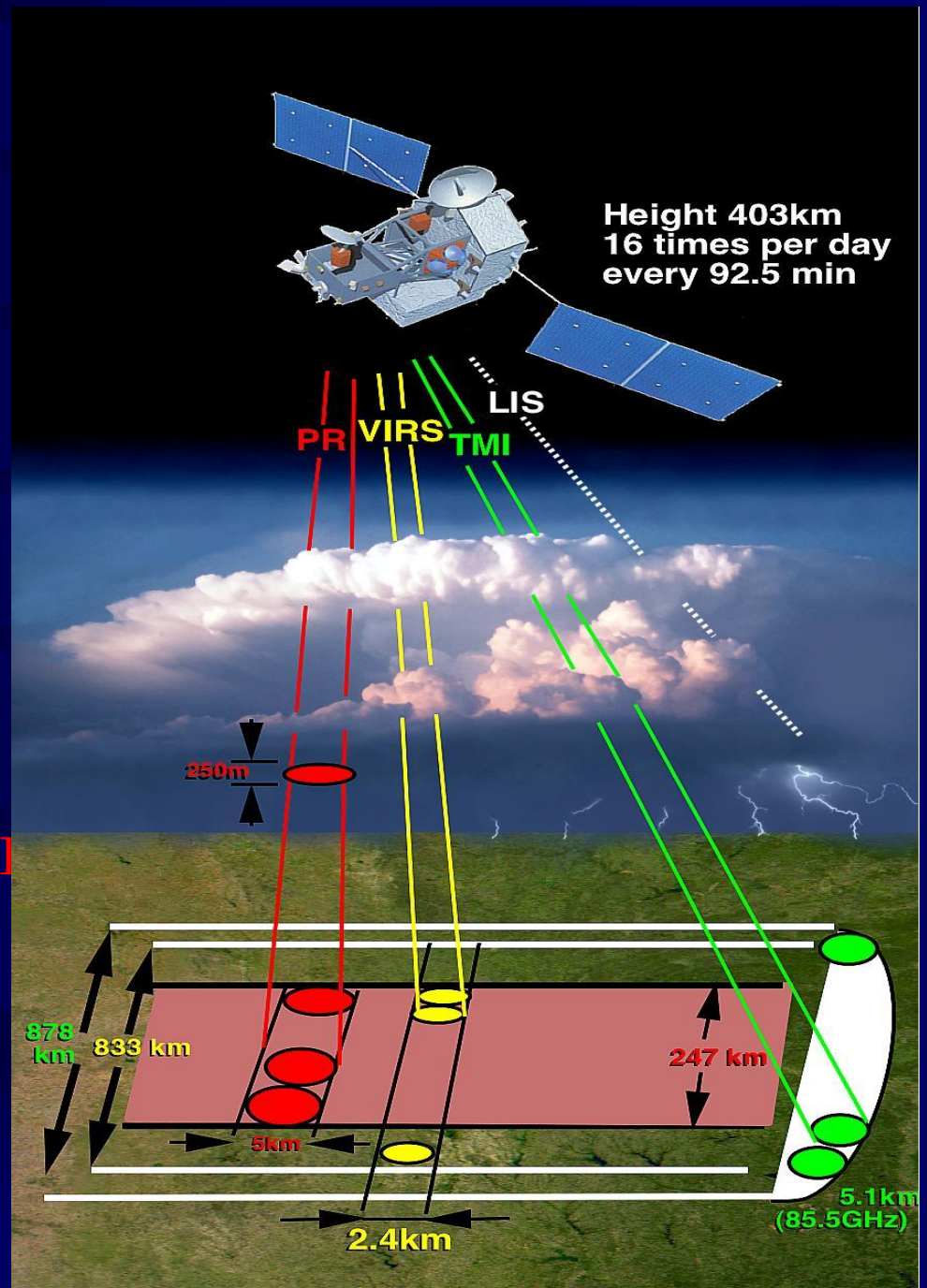
13.8 GHz  
cross-track scanning  
at 5 km resolution  
247 km swath

## Visible/infrared radiometer (VIRS) [U.S.]

0.63, 1.61, 3.75, 10.8, and  $12\mu\text{m}$   
**cross-track scanning**  
at 2.4 km resolution  
833 km swath

## Lightning Imaging Sensor (LIS) [U.S.]

Staring optical array



# Questions:

- How much rain is falling in the Tropics, especially over the ocean?
- If validating our model against TRMM precipitation, which TRMM product should we use?
- Does PR-based rainfall-temperature relations support TMI-based rainfall-temperature relations?

# Objectives:

- Develop a 15-year TRMM Composite Climatology (TCC) of surface rainfall over the Tropics using the strength of multiple estimates from TRMM.
- Compare the relations between monthly rainfall (PR & TMI) and surface temperature.

Wang et al. (2013, JCLI)

## *TRMM Rain Products for Composite*

### Mean of:

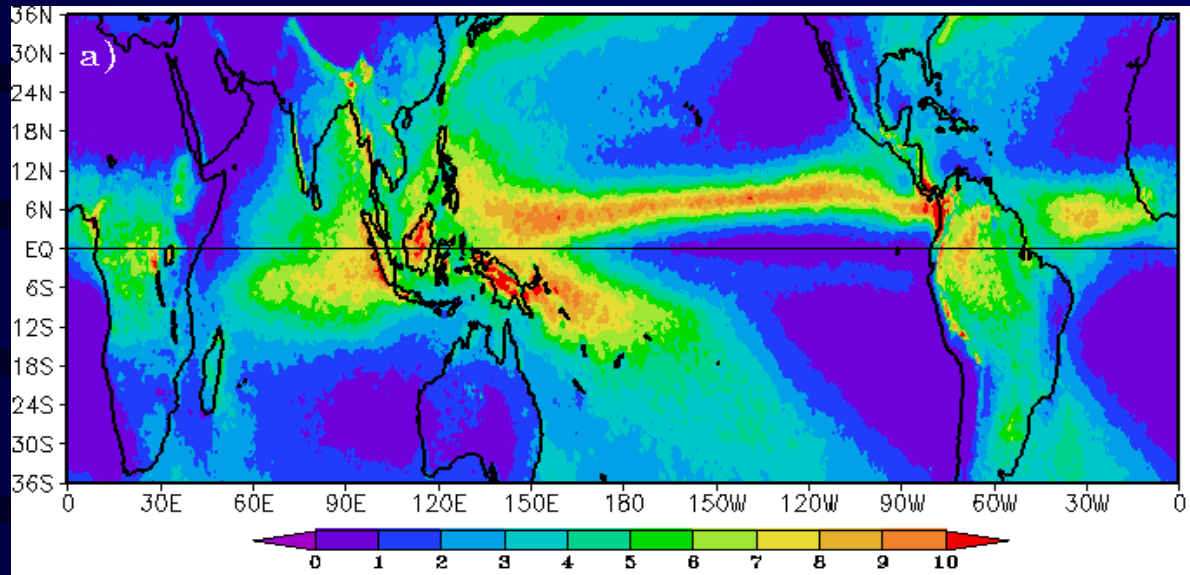
- 1) TMI (2A12)
- 2) PR (2A25)
- 3) Combined (2B31)

*TMI (2A12) over land is known to have obvious rainfall artifacts in some mountainous and semi-arid regions as a result of problems in rain-no rain screening (Wang et al. 2009).*

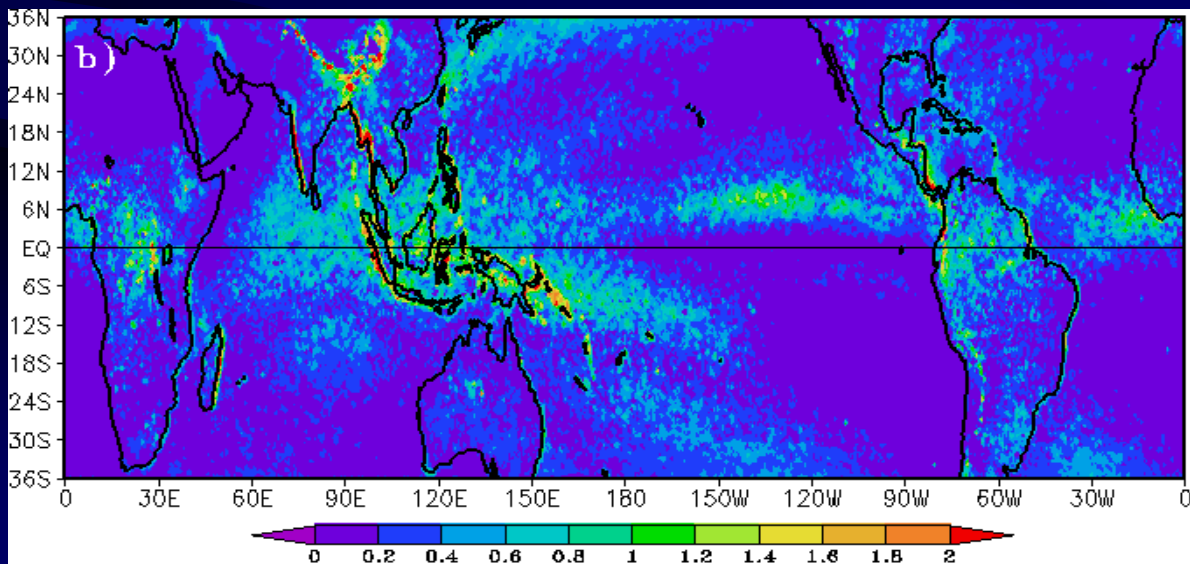
An automated quality-control scheme is implemented. The TMI month-of-the-year climatological data are excluded from TCC if one of criteria is met:

- 1) TMI rainfall is 50% more than the average of PR, PR-TMI combined, and TMPA rainfall; and, TMI rainfall is more than 1mm/d.
- 2) TMI rainfall is 50% less than the average of PR, PR-TMI combined, and TMPA rainfall; and, the average rainfall of other three products is more than 1mm/d.

# Fifteen-year (1998-2012) TRMM Composite Climatology (TCC)



Standard Deviation at each point as a measure of confidence

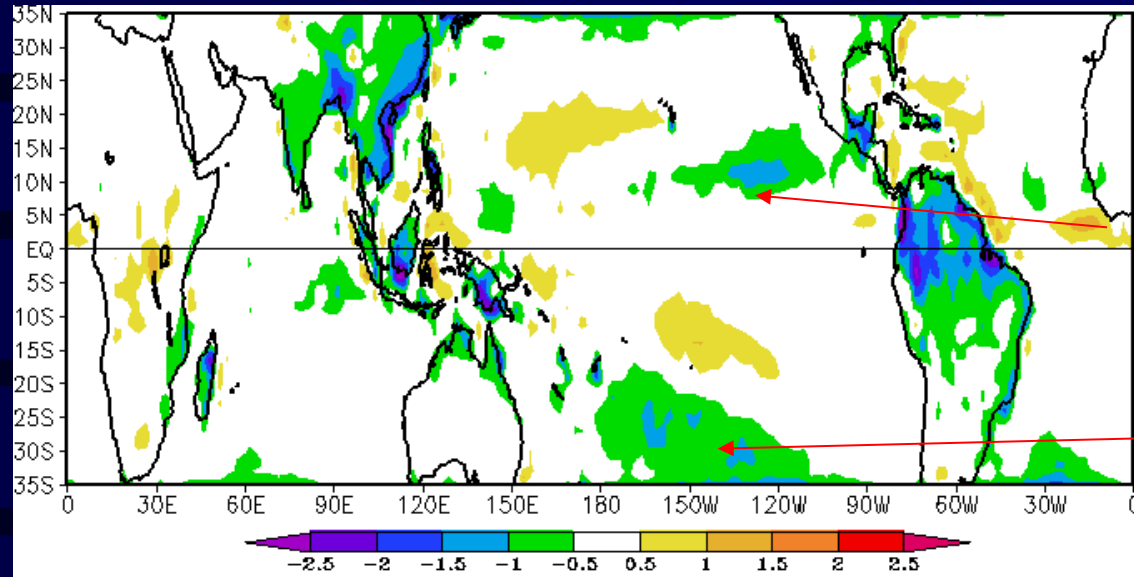


# *Evaluation and Validation*

## **I. Comparison with Global Precipitation Climatology Project (GPCP)**

*The GPCP Version 2 monthly analysis is a community-based analysis using both satellite and gauge data that is widely used and can be considered a standard to which new estimates can be compared.*

# TCC Compared to GPCP (1998-2009)



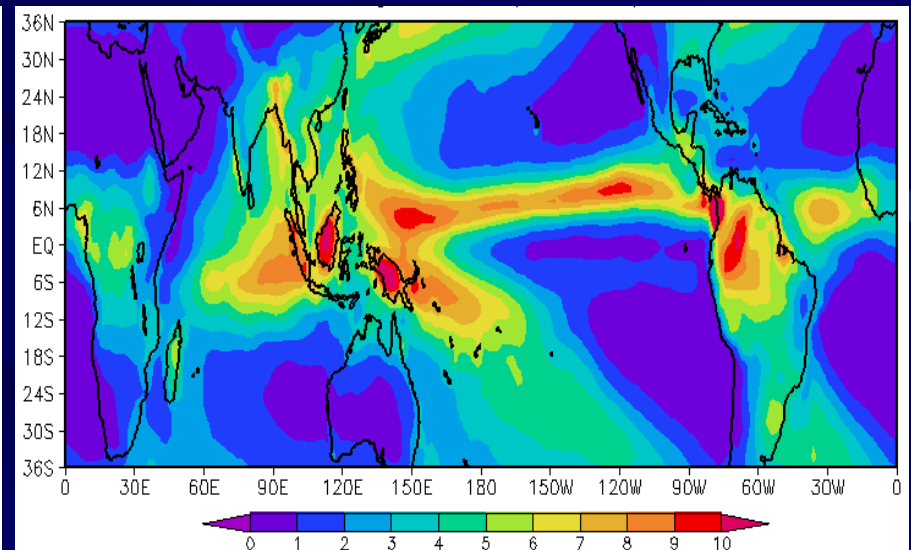
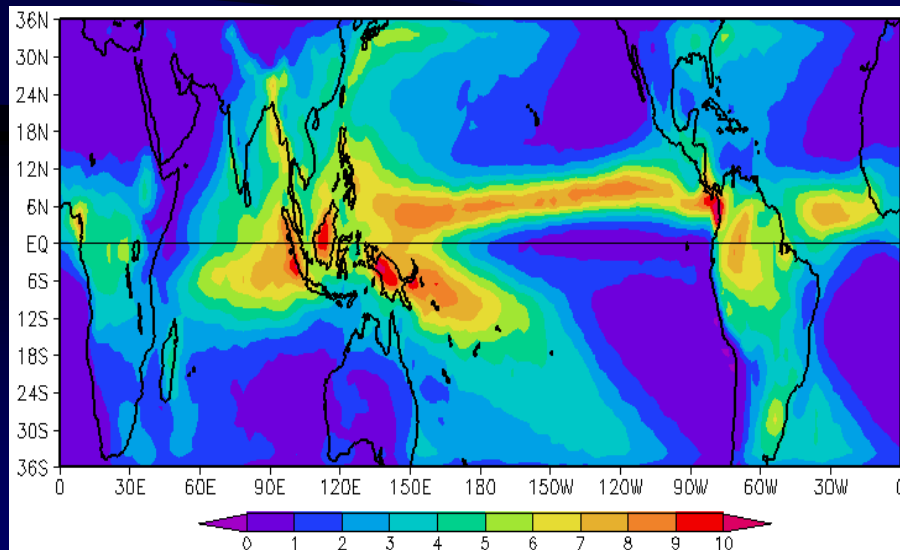
TCC-GPCP

1 mm/d out of  
~6 mm/d  
(17%)

1.25 mm/d out  
of ~5 mm/d  
(25%)

TCC (smoothed to 2.5°)

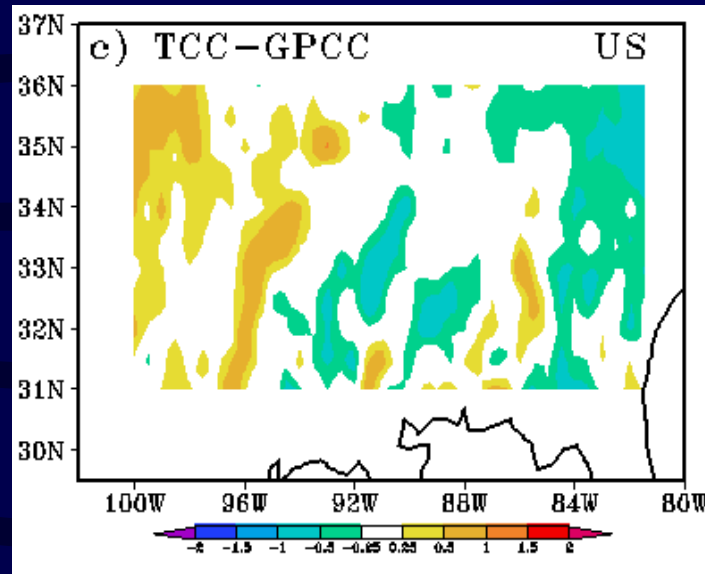
GPCP



## *Evaluation and Validation*

II. Comparison with Global Prediction  
Climatology Center (GPCC) gauge-based  
reanalysis.

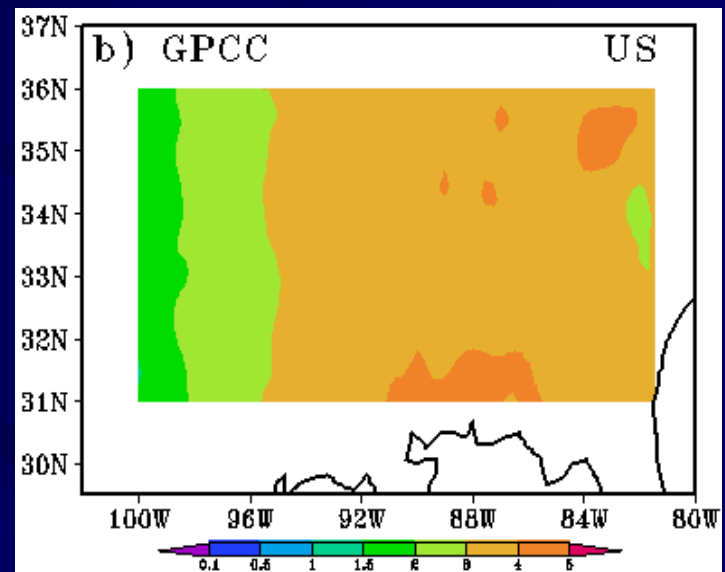
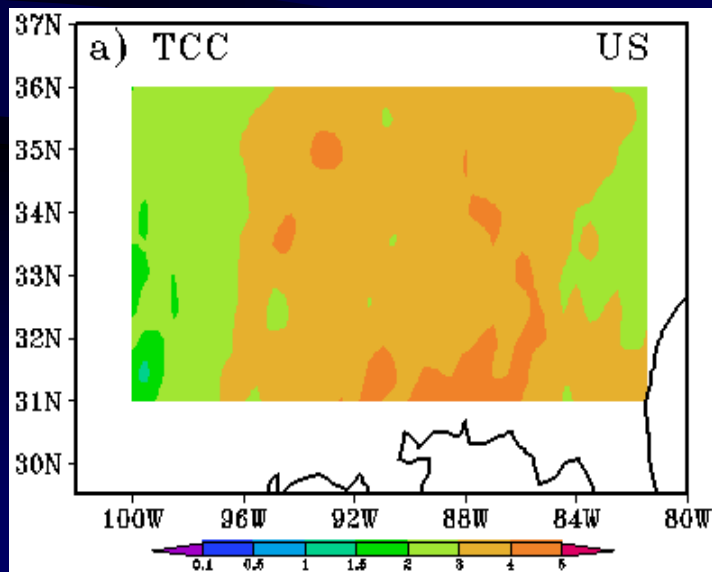
# TCC Compared to GPCC (SE US)



TCC-GPCC

TCC

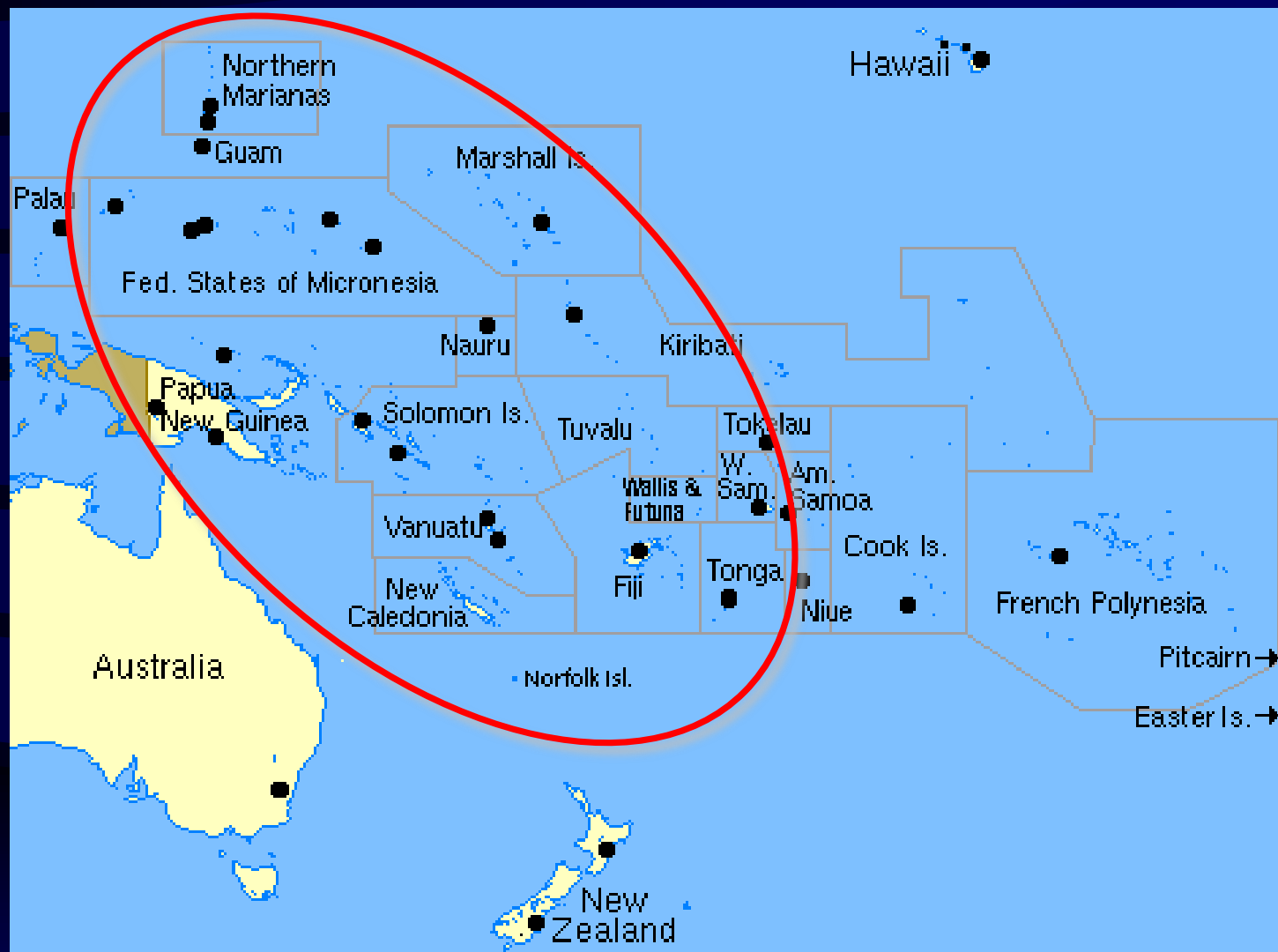
GPCC



# *Evaluation and Validation*

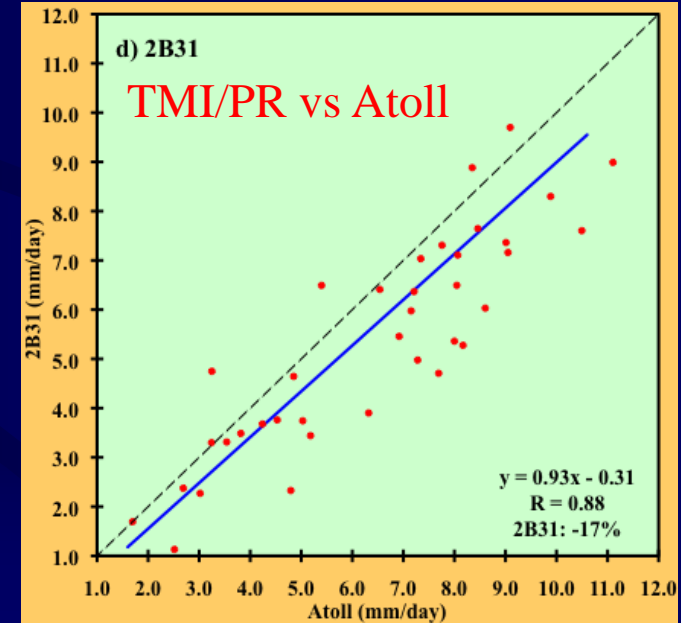
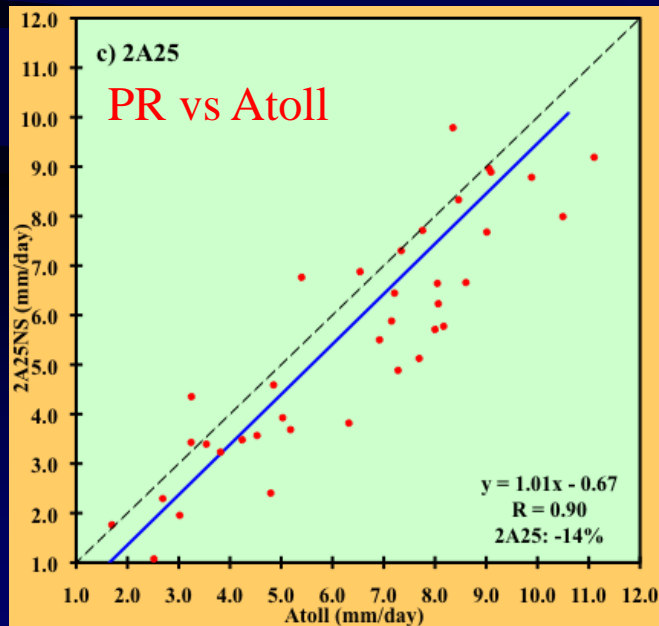
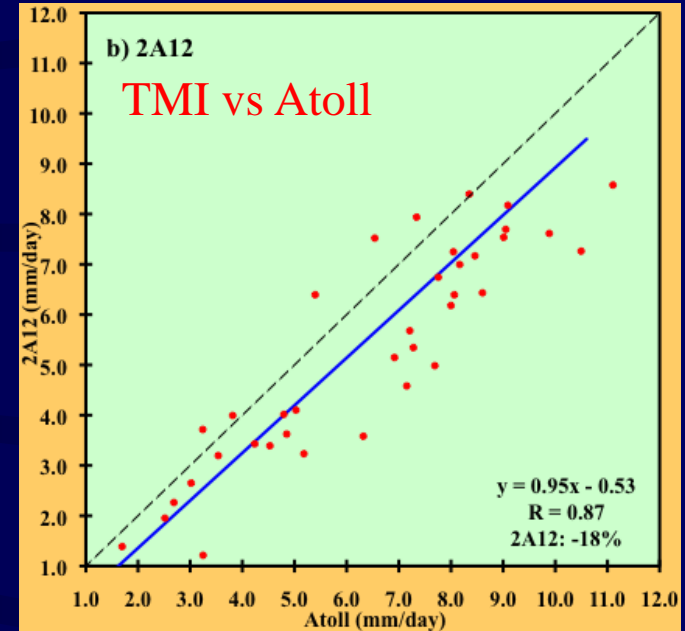
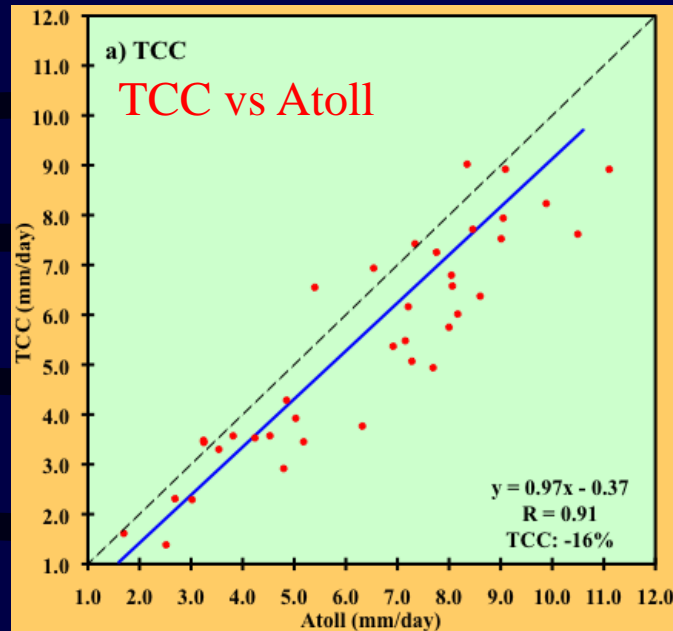
## III. Comparison with NOAA the Comprehensive Pacific Rainfall Database (PACRAIN).

*PACRAIN contains gauge rainfall data from the tropical Pacific basin. It has been used to analyze satellite-based precipitation algorithms [e.g. GPCP, Goddard Profiling Algorithms (GPROF)]*

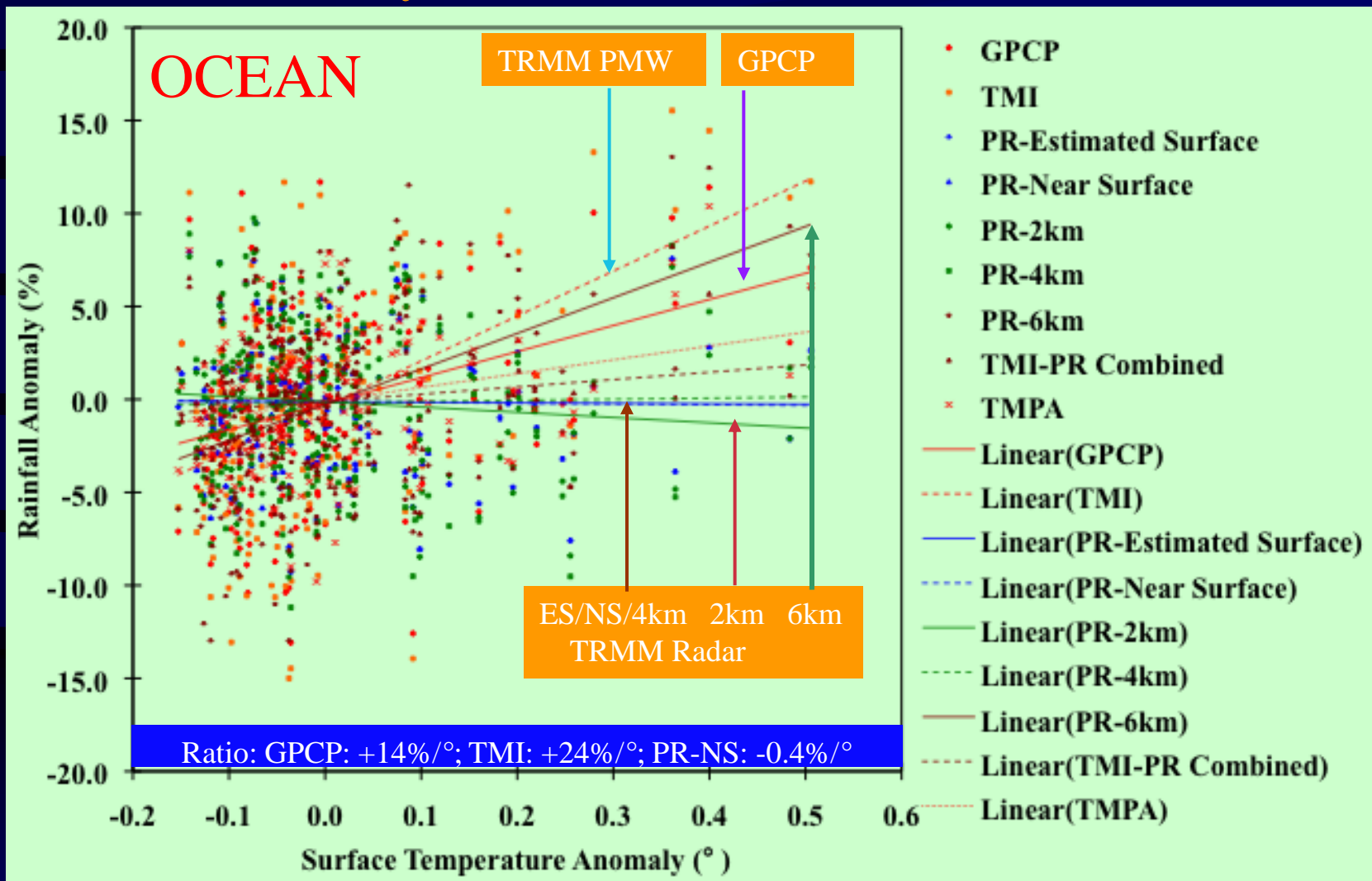


Only atoll rainfall data, hopefully representing open ocean rainfall, are used for comparison with TCC.

# TRMM vs. Atoll

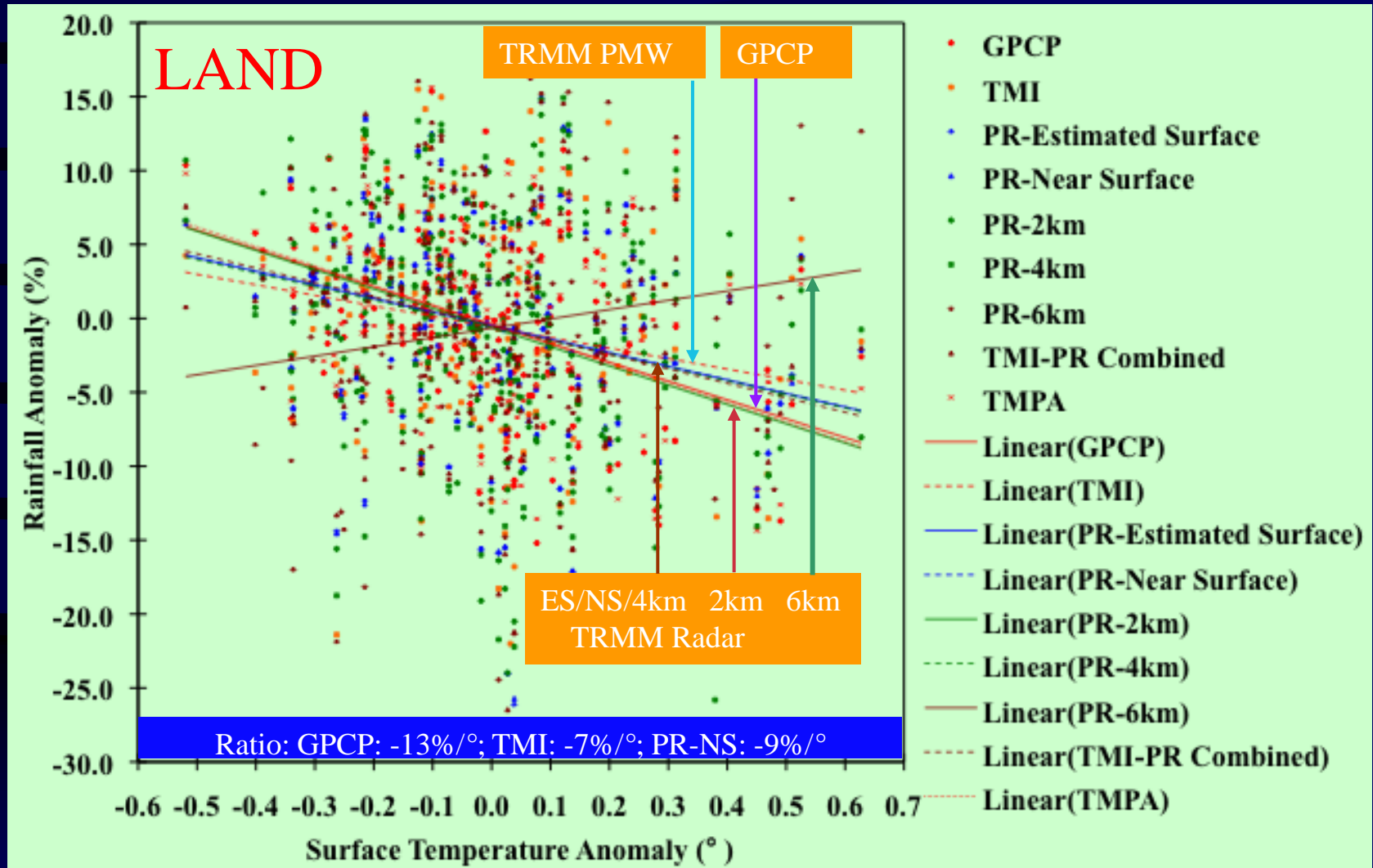


# Inter-annual Anomalies (25°N-25°S) Of Rain and Surface Temperature for TRMM Era (1998-2012)



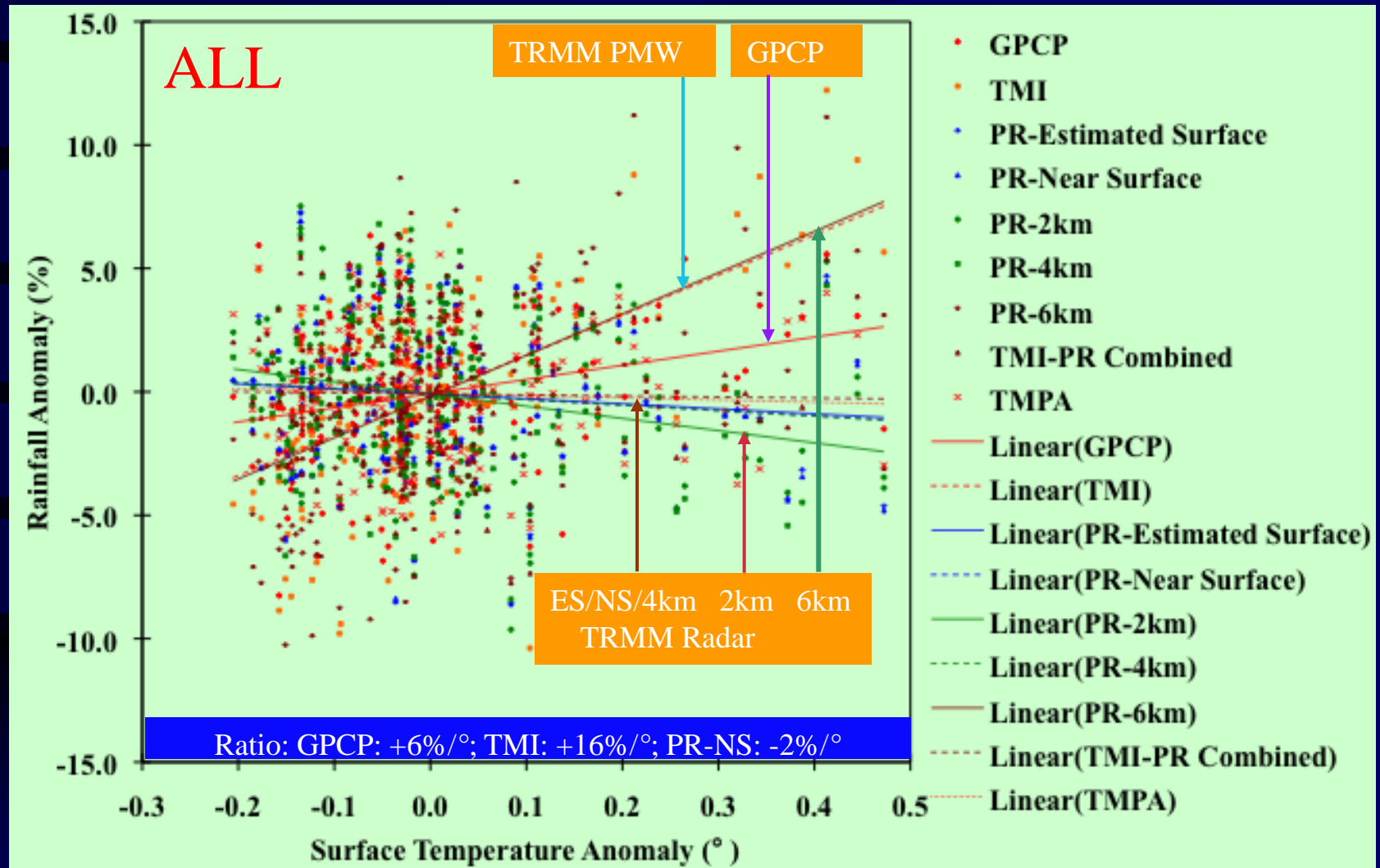
GPCP, TMI and PR at 6km show positive relation between rainfall and surface temperature;  
PR (sfc. To 4 km) show no clear relation between rainfall and surface temperature

# Inter-annual Anomalies (25°N-25°S) Of Rain and Surface Temperature for TRMM Era (1998-2012)



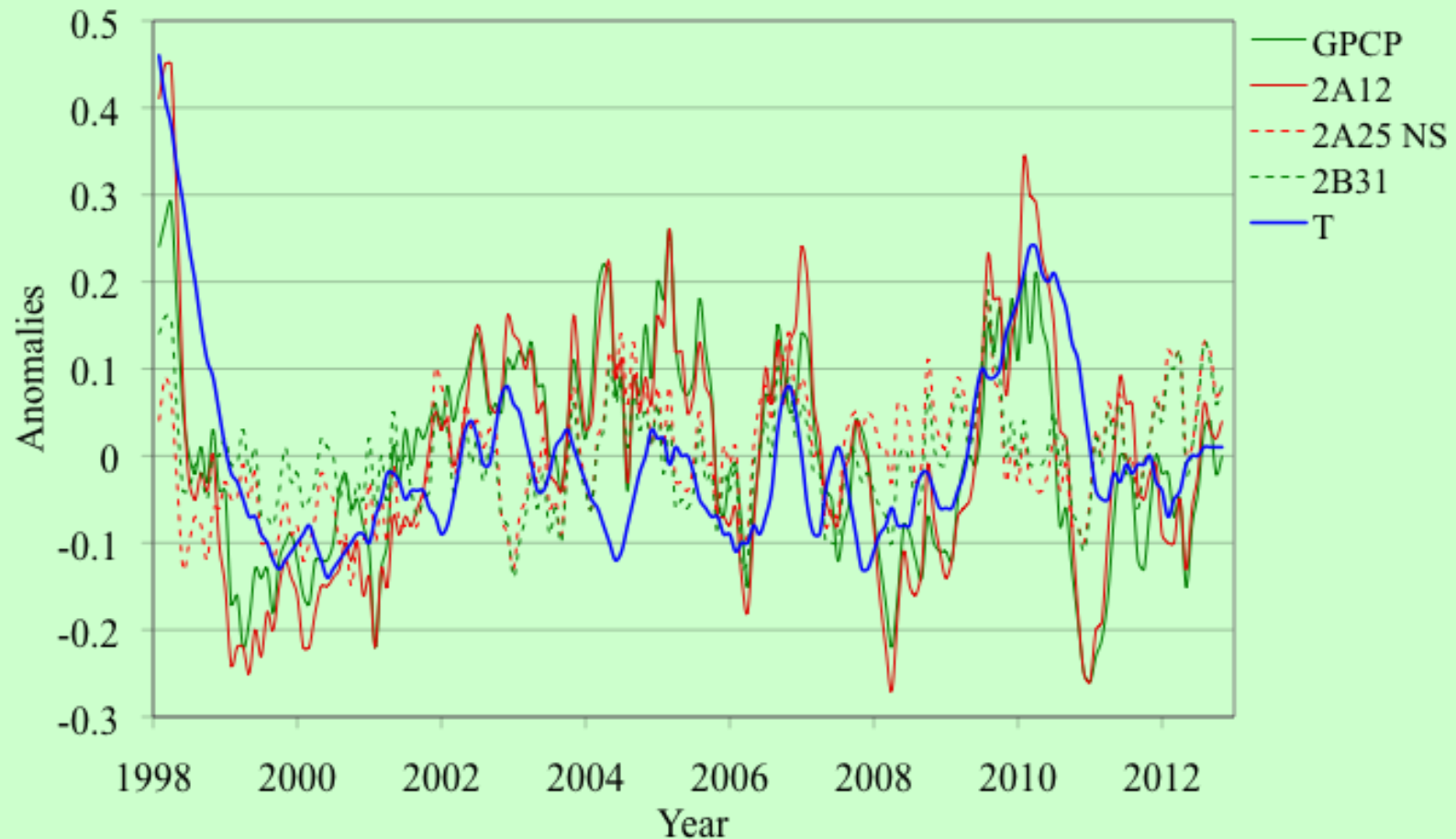
GPCP, TMI and PR (sfc. To 4 km) show negative relation between rainfall and surface temperature; PR at 6km show positive relation between rainfall and surface temperature

# Inter-annual Anomalies (25°N-25°S) Of Rain and Surface Temperature for TRMM Era (1998-2012)



GPCP, TMI and PR at 6km show positive relation between rainfall and surface temperature;  
 PR (sfc. To 4 km) show negative relation between rainfall and surface temperature

## Ocean (25S-25N)



The TMI rainfall data over ocean have good positive responses in the El Nino years, but PR rainfall data over ocean are far less sensitive to the ENSO events.

# Summary

- a) A 15-year TRMM-based tropical rainfall climatology has been developed that uses a composite of estimates from different TRMM instruments and techniques, removes artifacts and corrects for the 2001 orbit boost.
- b) Standard deviation of estimates can be used as measure of dispersion (and “error”) . TCC ranges should be useful for focusing attention on algorithm issues.
- c) The TCC dataset provides a summary of the rainfall measurements by the TRMM satellite. The applications of TCC may include: climate monitoring, climate variability studies, model initialization and verification, comparison with other satellite rainfall estimates.
- d) The PR-based surface precipitation-temperature slopes do not confirm slopes based on passive microwave observations. The TMI rainfall data over ocean have good positive responses in the El Nino years, while PR rainfall data over ocean are far less sensitive to the ENSO events.